

In the Claims:

Claims 1 to 44 (Canceled).

1     45. (New) A method for controlling, in closed loop fashion, the  
2     operation of an internal combustion engine including engine  
3     cylinders, said method comprising the following steps:

- 4     a)    sampling an engine speed signal,  
5     b)    applying a Hartley-transformation to said engine speed  
6           signal for transforming said engine speed signal into  
7           an angular frequency range,  
8     c)    analyzing said angular frequency range for producing  
9           individual angular frequency orders representing phase  
10          information and amplitude information,  
11    d)    performing a cylinder classification based on said  
12          phase information and said amplitude information by  
13          first comparing said phase information with a given  
14          reference phase value and by second comparing said  
15          amplitude information with a given first amplitude  
16          threshold value, said first comparing and said second  
17          comparing yielding individual cylinder informations  
18          for each cylinder of said engine cylinders,  
19    e)    processing said individual cylinder informations for  
20          identifying, based on said first phase comparing, any  
21          cylinder which is causing an uneven running of said  
22          internal combustion engine for further identifying,  
23          also based on said first phase comparing, a fuel  
24          adjustment direction for each individual cylinder

25 including said cylinder causing said uneven running,  
26 and for determining, based on said second amplitude  
27 comparing, an injection fuel quantity required for  
28 correcting said uneven running of said internal  
29 combustion engine,

30 f) generating in response to said processing a closed  
31 loop control signal and applying said closed loop  
32 control signal to an engine controller for correcting  
33 said uneven running of said internal combustion  
34 engine,

35 g) detecting a misfiring of any one of said engine  
36 cylinders by further comparing said amplitude  
37 information with a respective second given amplitude  
38 threshold value to provide information for concluding  
39 whether said uneven running is caused by said  
40 misfiring when said amplitude information exceeds said  
41 respective second given amplitude threshold value,

42 h) detecting an actual power output of said internal  
43 combustion engine,

44 i) comparing said actual power output with a rated power  
45 output of said internal combustion engine to provide  
46 a reduced power output information,

47 j) modifying said closed loop control signal in response  
48 to said reduced power output information, and

49 k) applying said modified closed loop control signal to  
50 said engine controller for controlling a fuel  
51 injection to all said engine cylinders for correcting

52                   said actual power output with reference to said rated  
53                   power output.

1     46.   (New) The method of claim 45, further comprising assuring  
2           that operating parameters of said internal combustion  
3           engine differ insignificantly from each other at a  
4           beginning and at an end of said sampling of said engine  
5           speed signal, performing said sampling so that at least two  
6           sequential speed signal segments are sampled, and forming  
7           a mean value of said at least two sequential speed signal  
8           segments.

1     47.   (New) The method of claim 46, wherein said forming of a  
2           mean value is performed to obtain an arithmetic mean value.

1     48.   (New) The method of claim 45, further comprising correcting  
2           any one of said individual angular frequency orders and  
3           said given reference phase value by performing the  
4           following substeps: temporarily stopping any fuel injection  
5           to said internal combustion engine to cause a towed  
6           operation, and performing said correcting as a towed  
7           correction for eliminating any parasitic effects from any  
8           one of said individual angular frequency orders and said  
9           given reference phase value.

1     49.   (New) The method of claim 45, further comprising performing  
2           said step (g) of detecting said misfiring by selecting out  
3           of said individual angular frequency orders low frequency

individual angular frequency orders and deriving said amplitude information from said low frequency individual angular orders for said comparing to determine a misfiring cylinder.

50. (New) The method of claim 45, further comprising performing the following substeps for said detecting of said misfiring of any one of said engine cylinders, providing speed and load dependent reference phases, combining said speed and load dependent reference phases to form a calibration factor, correlating said speed and load dependent reference phases to respective measured phases of said individual angular frequency orders for designating one of said engine cylinders as a first cylinder, and identifying said misfiring cylinder by taking into account said speed and load dependent reference phases, said calibration factor, knowledge of which cylinder is said first cylinder and that said amplitude information has exceeded said respective second given amplitude threshold value of step (g).

51. (New) The method of claim 50, wherein said individual angular frequency orders representing phase and amplitude information include at least an 0.5th order and a 1.0st order, and further comprising correlating said speed and load dependent reference phases to measured phases of said 0.5th order and said 1.0st order, so that a speed and load dependent reference phase of the 0.5th order that is

8        closest to the measured phase of the 0.5th order designates  
9        said first cylinder.

1       52. (New) The method of claim 45, further comprising  
2       establishing said rated power output by taking respective  
3       amplitude measurements from a reference engine, storing  
4       said amplitude measurements as a function of speed in a  
5       memory to provide said rated power output for use in said  
6       comparing in said step (i).

1       53. (New) An apparatus for controlling, in a closed loop  
2       control, the operation of an internal combustion engine, by  
3       performing the method of claim 45 said apparatus  
4       comprising: a speed signal sampling sensor (3) for  
5       generating an engine speed signal, a frequency analyzer (5)  
6       having an input for receiving said engine speed signal for  
7       performing a Hartley-transformation on said engine speed  
8       signal thereby converting said engine speed signal into an  
9       angular frequency range, said frequency analyzer (5)  
10       producing from said angular frequency range individual  
11       angular frequency orders, a cylinder classifier (7) having  
12       an input connected to an output of said frequency analyzer  
13       (5), and a controller (8) having an input connected to an  
14       output of said cylinder classifier for receiving an input  
15       signal from said cylinder classifier for generating a  
16       closed loop control signal, said controller (8) having an  
17       output connected to said internal combustion engine for  
18       said closed loop control, wherein said signal sampler

19 sensor (3), said frequency analyzer (5) and said cylinder  
20 classifier (7) are adapted for detecting a misfiring  
21 cylinder of said internal combustion engine, and wherein  
22 said signal sampler sensor (3), said frequency analyzer  
23 (5), said cylinder classifier (7) and said controller (8)  
24 are further adapted for generating closed loop control  
25 signals for said internal combustion engine for tracking  
26 any one of an engine torque and an engine power output.

1 54. (New) The apparatus of claim 53, further comprising a  
2 computer (4) operatively interposed between said signal  
3 sampler sensor (3) and said frequency analyzer (5) for  
4 calculating an arithmetic mean value of a plurality of said  
5 individual angular frequency orders.

1 55. (New) The apparatus of claim 53, further comprising a  
2 frequency corrector (6) operatively interposed between said  
3 frequency analyzer (5) and said cylinder classifier (7) for  
4 correcting said individual angular frequency orders.

1 56. (New) The apparatus of claim 53, wherein said cylinder  
2 classifier (7) comprises a generator (71) for generating  
3 reference phases, a calibrator (72) for calibrating said  
4 reference phases, and a selector (73) for selecting a  
5 reference phase, said cylinder classifier (7) further  
6 comprising means (74) for determining weighting factors,  
7 means (75) for determining any one of primary and secondary  
8 causers of any one of a disturbance and a deviation, and

9 means (76) for generating qualitative fuel injection  
10 adjustment control signals for adjusting a fuel supply for  
11 said internal combustion engine, said generating of said  
12 fuel injection adjustment control signals taking into  
13 account any one of qualitative and quantitative parameters.

1 57. (New) The apparatus of claim 53, wherein said controller  
2 (8) comprises any one of an I-control circuit and a  
3 PI-control circuit.

**[RESPONSE CONTINUES ON NEXT PAGE]**